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RED-NAPED SAPSUCKER NEST TREES IN NORTHERN ROCKY MOUNTAIN OLD-GROWTH FOREST

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ABSTRACT.—Throughout western North America, Red-naped Sapsucker (*Sphyrapicus nuchalis*) nests have been previously described primarily in trembling aspen (*Populus tremuloides*) with decay-softened wood. During 1974–1992, we located Red-naped Sapsucker nest trees (n = 125) in northwestern Montana old-growth coniferous forest that included widely scattered paper birch (*Betula papyrifera*). Sapsucker nests were in nine tree species (seven conifers). Most (68%) nest trees were live and 75% had broken tops. Western larch (*Larix occidentalis*) and birch were greatly over utilized compared to their availability. Larch nest trees (n = 84) were large [mean DBH = 69 ± 20.95 (SD) cm]. Mean DBH of birch nest trees (n = 30) was 37 ± 8.42 cm. All Mountain Chickadee (*Poecile gambeli*) nests (n = 36) and 12 of 23 Red-breasted Nuthatch (*Sitta canadensis*) nests were in old sapsucker excavated nest holes. Wood of larch and birch is inherently harder than that of aspen (specific gravity = 0.48, 0.48, and 0.35 respectively), posing a potential obstacle for relatively weak excavators such as sapsuckers. However, the entire inner wood column of birch is susceptible to decay fungi and the durable bark is thin. In larch sapsuckers mitigated the difficulty by selecting trees with extensive heartwood decay (old larch) and by excavating in the upper bole (mean cavity height = 21.5 m), where the bark is thinner. External evidence of heartwood decay was present in 87% of larch and 86% of birch. Decay incidence increases with age in western larch forests, amplifying their value as habitat for sapsuckers and many other species. Perpetuation of old-growth western larch is an important component in the conservation of biological diversity. *Received 8 March 1999, accepted 24 August 1999.*

General ornithological references for the northern Rocky Mountains allude to the Red-naped Sapsucker's (*Sphyrapicus nuchalis*) nesting dependance on trembling aspen (*Populus tremuloides*), riparian woods, and orchards (Johnsgard 1986, Ehrlich et al. 1988), or on deciduous and mixed woodlands where poplar (*Populus* spp.) and birch (*Betula* spp.) are common (McGillivray and Semenchuck 1998). Sapsucker selection of trembling aspen (hereafter, aspen) nest trees in western North America has been well documented (Erskine and McLaren 1972, British Columbia; Crockett and Hadow 1975, Colorado; and Li and Martin 1991, central Arizona). In western Montana, Weydemeyer and Weydemeyer (1928) described the Red-naped Sapsucker as nesting most commonly in live aspen. Before our study, old-growth conifer stands in the western United States had not been included in the description of quality habitat for sapsuckers. Following our study, Tobalske (1992) studied habitat suitability related to Red-naped Sapsucker fledging success in part of our old-growth study area.

Our objectives were to (1) locate and describe active sapsucker nest trees in old-growth coniferous forest, (2) compare sapsucker nest trees to those of other woodpecker species, and (3) identify secondary cavity nesters that used old sapsucker holes. Preliminary results of our study were reported in McClelland and Frissell (1975) and McClelland and coworkers (1979).

STUDY AREA AND METHODS

Our study, 1974–1992, began at a time when the U.S. Forest Service had insufficient data for evaluating impacts of forest harvesting on cavity nesters in old-growth forests of the northern Rocky Mountains. We focused on the Coram Experimental Forest (approximately 48° 21′ N, 114° 00′ W), an International Biosphere Reserve encompassing 3019 ha (including a 324 ha natural area) in the Flathead National Forest, northwestern Montana (U.S. Forest Service 1979). Elevations range 1188–1615 m. Coram forest's climate is typical of similar terrain in the northern Rocky Mountain region (Hungerford and Schlicter 1984). About 70% of the Coram forest had not been cut and was classified as mature or old (H. Trechsel, pers. comm.). The old-growth component of the uncut forest was dominated by Douglas-fir (*Pseudotsuga menziesii*) and western larch (*Larix occidentalis*; hereafter, larch; U.S. Forest Service 1979). Some easily accessible large trees were selectively cut as early as 1916 and research oriented harvesting (clearcuts and selection cutting) began in the 1940s. During our study, previous clearcuts (16% of the CEF) supported young stands of

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conifers dominated by larch (too small for cavity nests), with isolated stems or small groves of paper birch (*Betula papyrifera*; hereafter, birch), and an occasional remnant conifer snag. Although mature groves of aspen were not present immediately within the old growth we examined, some were nearby in localized areas of the Flathead National Forest and Glacier National Park.

During May through August, 1974–1992, we searched old-growth forest at Coram for active cavity nests of all species, but here we focus on the Red-naped Sapsucker. We walked roads and trails, and randomly selected cross-country routes. By the end of 1992, all major old growth on the Coram forest had been searched. Within logged old-growth sites abutting existing old growth, cavity nests in remnant trees were recorded if they were discovered from the uncut stands we were searching. In nearby Glacier National Park and the Flathead National Forest, we hiked trails and cross-country routes selected to maximize observation of old-growth Douglas-fir/larch stands.

To find active woodpecker nests, we let the birds lead us to the active nest trees; we did not focus on any tree species or forest stand within the surveyed areas. We used visual cues (observation of an incubation exchange by adults, or a food carrying adult flying to and entering a hole), and auditory cues (vocalizations of young in the nest). During the two weeks before fledging, vocalizations of woodpecker nestlings, especially sapsuckers, sometimes carry 100 m or more (Kilham 1977). To find active nests of secondary cavity nesters [e.g., chickadees (*Poecile* spp.) and nuthatches (*Sitta* spp.)] we used similar visual cues, but without the advantage of auditory clues from the young. For all cavity nests, we recorded the nest as active only if incubation or the presence of young was confirmed. Nest status was observed from the ground. Near low nests, vegetative concealment was used to prevent disturbance. Easily accessible sapsucker nest trees were revisited the year following their first documented use. Time limitations required a choice between revisiting all previously located nest trees or searching for nest trees in previously unsurveyed portions of the study area. We chose to emphasize the latter.

At nest trees, tree condition was characterized by presence of dead wood and tree structure: intact top snag, broken top snag, broken top live, dead top live, or live top live. We also recorded tree species, diameter at breast height (DBH), tree height, percent canopy cover (ocular estimate), basal area of the surrounding forest (measured with a Spiegel Relaskop), nest height, azimuth of the nest opening, and number of prior nest holes. Presence of heartwood decay was confirmed by: (1) a conk (external fruiting body of heartwood-decay fungus; Parks et al. 1997); (2) swollen punk knots and resinosis (Boyce 1948, Partridge and Miller 1974, Manion 1981); (3) decayed heartwood visibly exposed in the nest opening, woodpecker feeding excavations, cracks, or wounds; (4) evidence of carpenter ant (*Camponotus* spp.) galleries within the tree (Sanders 1964); and (5) an old broken top or fire scar (Bull et al. 1997, Parks et al. 1997). We searched for cavity excavation chips on the ground at the base of each nest tree. Chips were examined for visible evidence of decay as described by Partridge and Miller (1974) and Parks and coworkers (1997; e.g., typical white "pockets" or bleached areas). The woodpecker species responsible for prior holes was identified using Headstrom's (1970) key and reliance on our 40 years experience observing woodpecker nest construction.

We did not sample the surrounding forest at each nest tree. However, the U.S. Forest Service concurrently sampled plots (32 ha, pooled) characterized as representative of Coram Experimental Forest's uncut forest. They recorded total tree counts by species and size. To enable a comparison of availability and nest-tree selection, we used their sample of trees at least 23 cm DBH (coincidentally, the smallest sapsucker nest tree DBH we found) to provide a crude indicator of potential nest-tree availability. Composition of the sample sites was: Douglas-fir (52% of all tree species present, mean DBH = 38 cm), subalpine fir (*Abies lasiocarpa*; 22%, 28 cm), Engelmann spruce (*Picea engelmannii*; 12%, 33 cm), larch (11%, 49 cm), western hemlock (*Tsuga heterophylla*; 1%, 32 cm), lodgepole pine (*Pinus contorta*; 1%, 30 cm), western white pine (*Pinus monticola*; 1%, 33 cm), western red cedar (*Thuja plicata*; <1%, 37 cm), and birch (<1%, 33 cm; R. Benson, pers. comm.). Birch were isolated within the old growth, primarily in riparian zones. We recognized that old-growth forest composition outside the Coram forest might differ from the U.S. Forest Service Coram study plots. Therefore, we used only those sapsucker nest trees found on the Coram forest to compare with the expected values derived from the Coram forest sample sites. χ^2 goodness of fit analyses were used to compare sapsucker nest trees with available trees. Resulting standardized residuals (Everitt 1992) were used to further illustrate differences.

In comparisons of tree species, differences in characteristics were examined with *t*-tests. We tested for differences among nest trees (DBH and cavity height) for sapsuckers and other woodpecker species using ANOVA, followed by Fisher's Least Significant Difference method ($\alpha = 0.05$) for individual comparisons when the overall ANOVA was significant. All analyses were made using PCSAS on a Windows platform (SAS Inst. 1996). Where ± values are reported, they represent SD.

RESULTS

In the Coram Experimental Forest, nest excavation by Red-naped Sapsuckers began in early to mid-May and young fledged mid-July to early August. We discovered most nests (76%) during the later stage of nestling development, when their vocalizations carry the farthest. Detections probably were biased toward trees with successful nests (Mayfield

TABLE 1. Red-naped Sapsucker nest-tree characteristics, northwestern Montana.

Tree species		DBH (cm)	Tree height (m)	Cavity height (m)	Basal area (m^2/ha)	Canopy cover (%)
Western larch	(n = 84)					
(*Larix occidentalis*)	range	36–119	11.3–50.6	7.9–42.7	0–74	0–100
	$\bar{x}$ (±SD)	69 (20.95)	29.9 (9.12)	21.5 (7.34)	23 (11.54)	33 (15.64)
Paper birch	(n = 30)					
(*Betula papyrifera*)	range	23–58	7.6–18.0	3.0–14.9	0–46	0–50
	$\bar{x}$ (±SD)	37 (8.42)	13.2 (2.68)	9.8 (2.57)	14 (11.62)	23 (15.78)
All others[a]	(n = 11)					
	range	30–81	3.5–36.6	1.4–30.5	5–44	5–50
	$\bar{x}$ (±SD)	45 (15.92)	17.3 (11.11)	12.2 (9.08)	28 (14.67)	34 (19.74)
All nest trees	(n = 125)					
	range	23–119	3.5–50.6	1.4–42.7	0–74	0–100
	$\bar{x}$ (±SD)	59 (23.31)	24.8 (11.09)	17.9 (8.48)	21 (12.44)	30 (16.27)

[a] Four Engelmann spruce (*Picea engelmannii*), two subalpine fir (*Abies lasiocarpa*), one lodgepole pine (*Pinus contorta*), one ponderosa pine (*Pinus ponderosa*), one western hemlock (*Tsuga heterophylla*), one western redcedar (*Thuja plicata*), and one black cottonwood (*Populus trichocarpa*).

1961, Tobalske 1992) and nests closer to the ground, from which vocalizations were most audible.

Nest trees.—We located 125 Red-naped Sapsucker nest trees in old-growth forest. Larch and birch represented 91% of all nest trees, 67% and 24% respectively; seven other tree species made up the remaining 9% (Table 1). Most (68%) nest trees were live and 75% had broken tops (Table 2). External evidence of heartwood decay was present in 87% of larch and 86% of birch. Conks or swollen punk knots were observed on 67% of larch and 66% of birch. All larch (13%) and birch (14%) without specific external evidence of decay had either dead or broken tops. All sapsucker nest excavation chips had visual evidence of decay (e.g., white pockets or bleached areas).

Nineteen of the 30 birch nest trees were within old-growth conifer stands; 11 were remnants in adjacent clearcut old growth. Considering nest trees only in Coram (n = 98), all tree species were not used in proportion to their availability (χ^2 = 1046.45, 3 df, $P < 0.001$). Larch and birch were greatly over utilized whereas Douglas-fir and all other species (grouped) were greatly under utilized (standardized residuals = 18.04, 25.27, −7.14, and −5.60 respectively). We found no significant difference in nest-hole orientation of sapsucker nests (n = 135, χ^2 = 5.740, 7 df, $P > 0.05$).

In addition to sapsuckers, we found five other woodpeckers nesting in old growth: Pileated Woodpecker (*Dryocopus pileatus*), Northern Flicker (*Colaptes auratus*), Hairy Woodpecker (*Picoides villosus*), Three-toed Woodpecker (*P. tridactylis*), and Black-backed Woodpecker (*P. arcticus*). In larch, sapsuckers nested highest and only Pileated

TABLE 2. Red-naped Sapsucker nest-tree conditions based on tree structure and relative amount of dead wood, in northwestern Montana.

Nest tree species	Tree condition: Intact-top snag	Broken-top snag	Broken-top live	Dead-top live	Live-top live	Totals
Western larch (*Larix occidentalis*)	3	19	38	15	9	84
Paper birch (*Betula papyrifera*)	0	11	18	1	0	30
All others[a]	1	6	2	1	1	11
Totals	4	36	58	17	10	125

[a] See Table 1 for list of species.

TABLE 3. Comparison of western larch nest trees used by Red-naped Sapsuckers and other woodpeckers in old-growth forest, northwestern Montana.

Woodpecker species	Larch nest trees *n*	Larch nest trees %[a]	Cavity height (m) Mean ± SD[b]	DBH (cm) Mean ± SD[b]
Red-naped Sapsucker (*Sphyrapicus nuchalis*)	84	67	21.5 ± 7.34 (A)	69 ± 20.95 (A)
Norther Flicker (*Colaptes auratus*)	18	55	18.0 ± 9.64 (A,B)	67 ± 27.09 (A,B)
Pileated Woodpecker[c] (*Dryocopus pileatus*)	52	53	17.5 ± 5.71 (B)	77 ± 14.25 (B)
Hairy Woodpecker (*Picoides villosus*)	15	56	14.7 ± 9.81 (B,C)	41 ± 18.69 (C)
Three-toed Woodpecker (*Picoides tridactylis*)	7	23	8.9 ± 6.55 (C,D)	33 ± 7.59 (C)
Black-backed Woodpecker (*Picoides arcticus*)	5	45	4.7 ± 4.41 (D)	30 ± 13.79 (C)

[a] % of total nest tress that were larch, for each woodpecker species.
[b] Following the SD, the same letter among the species indicates means are not different, based on Fisher's LSD ($\alpha = 0.05$).
[c] See McClelland and McClelland (1999) for a detailed description of Pileated Woodpecker nest and roost trees.

Woodpeckers selected larger diameter nest trees (Table 3).

Reuse of sapsucker nest trees.—About half of the active sapsucker nest trees we checked in successive years ($n = 42$) had an active sapsucker nest both years. Reuse was more common in larch than in birch (62% and 38%, respectively). In 27% of reused trees, the same nest cavity was used (Table 4). Larch nest trees had up to 40 sapsucker nest holes from previous years ($\bar{x} = 4 \pm 5.96$). Birch nest trees had up to 10 additional holes ($\bar{x} = 2 \pm 1.93$). All Mountain Chickadee (*Poecile gambeli*) nests ($n = 36$) were in holes previously excavated by sapsuckers. Most ($n = 33$) were in larch and none was in birch. As expected, Mountain Chickadee larch nest-tree mean DBH (62 ± 23.25 cm) and mean cavity height (20.1 ± 8.07 m) were not different from sapsucker nest trees ($t = 1.62$, 115 df, $P > 0.05$, and $t = 0.94$, 115 df, $P > 0.05$, respectively).

When Red-breasted Nuthatches (*Sitta canadensis*) nested in existing sapsucker cavities (12 of 23 nests), most (11 of 12) were in larch. Nuthatches also excavated original cavities ($n = 11$). When they excavated in larch ($n = 5$), they chose well-decayed trees or snags that were smaller (mean DBH = 41 ± 26.07 cm) than the larch nest trees in which they used abandoned sapsucker cavities (mean DBH = 65 ± 15.64 cm; $t = -2.38$, 14 df, $P < 0.05$). Two Tree Swallow (*Tachycineta bicolor*) nests were in old sapsucker holes, one each in isolated larch and birch. Four cavity nesting species used eight nest trees concurrently with sapsuckers: Mountain Chickadee (5 trees, all in old sapsucker cavities), Chestnut-backed Chickadee (*Poecile rufescens*; 1, in an old sapsucker cavity), Red-breasted Nuthatch (1, in an old sapsucker cavity), and Hairy Woodpecker (1, in a cavity it excavated). Pileated Woodpecker cavities were used by several other birds and small mammals (McClelland and McClelland 1999). One Northern Flicker

TABLE 4. Nest tree and nest cavity reuse by Red-naped Sapsuckers in northwestern Montana. Nest trees ($n = 42$) were observed in two consecutive years.

Nest tree species[a]		No. nest trees not reused	No. nest trees reused: Same hole	No. nest trees reused: New hole	Total no. nest trees reused	%
Western larch (*Larix occidentalis*)	($n = 26$)	10	4	12	16/26	(62)
Paper birch (*Betula papyrifera*)	($n = 16$)	10	2	4	6/16	(38)
Totals	($n = 42$)	20	6	16	22/42	(52)

[a] Insufficient data for other species.

nest hole in a birch was used by an American Kestrel (*Falco sparverius*). We detected no subsequent use of Hairy Woodpecker, Three-toed Woodpecker, or Black-backed Woodpecker cavities.

Other secondary cavity nesters.—In contrast to Mountain Chickadees, Black-capped Chickadees (*Poecile atricapillus*) nested only in cavities they excavated in well-decayed trees (n = 12; including 7 birch and 2 larch). Their nest trees were isolated or on forest edges, never in the interior of old-growth stands. Nest trees were small (mean DBH = 22 ± 10.27 cm) with cavities low ($\bar{x}$ = 5.0 ± 5.39 m). Black-capped Chickadees exhibited the unique strategy of excavating downward in broken-top birch (n = 4), entirely avoiding the bark. In their two larch nest trees, they excavated only 36 cm and 61 cm above the ground at sites with no bark. Each of 10 Brown Creeper (*Certhia americana*) nests was in a snag, in a natural cavity underneath bark that receded from the main stem. Mean DBH of nest trees was 43 ± 18.15 cm and mean cavity height was 6.3 ± 5.06 m. No Brown Creeper nest was in larch; three were in Douglas-fir, three ponderosa pine (*Pinus ponderosa*), two lodgepole pine, one Engelmann spruce, and one subalpine fir.

DISCUSSION

Red-naped Sapsuckers are weak excavators that "can deliver only light blows" (Spring 1965:473). Consequently, they would be expected to select nest trees with soft wood or with wood substantially softened by wood decay. Yellow-bellied Sapsuckers (*Sphyrapicus varius*) in the northeastern United States select aspen infected with *Phellinus igniarius* (Kilham 1971). In Colorado and Wyoming, Crockett and Hadow (1975) found all Red-naped Sapsucker nests (n = 51) in aspen, most of which were infected with *P. igniarius*. Daily and coworkers (1993) described the sapsucker as restricted to aspen nesting habitat in Colorado, with nest trees affected by *P. igniarius*. Within a large burn in Glacier National Park, Montana, Caton (1996) found Red-naped Sapsucker nests primarily in aspen (93%). Even undecayed aspen wood is relatively soft [specific gravity = 0.35 (Panshin and deZeeux 1970)] as is the bark, which is easily penetrated. Aspen is not resistant to decay (Manion 1981) and decay produces a central column of softened wood. These factors make aspen a tree easily excavated by sapsuckers.

Unexpectedly, in Montana, Red-naped Sapsuckers were common nesters in old-growth conifer forest, favoring larch and birch. Compared with aspen, larch and birch both are harder [specific gravity of undecayed wood = 0.48 (Panshin and deZeeux 1970)]. Because of the hard wood and tough bark, decay probably is more critical in larch and birch nest trees than in aspen. Birch is not resistant to decay and the inner wood is susceptible to heartrot fungi, especially *Phellinus igniarius* (Bull et al. 1997) and *Fomes fomentarius* (Parks et al. 1997). Although birch bark is durable, it is thin, providing only a brief obstacle to excavation. The remaining bark serves as a shell that surrounds and protects a cavity excavated in the decay-softened wood.

In larch, not only is the wood hard, the sapwood is slower to decay than is the heartwood and the bark is thick. Even the Pileated Woodpecker, a strong excavator, selects larch with heartwood decay (McClelland and McClelland 1999). Sapsuckers apparently avoid the potential impediments in larch by selecting nest trees with extensive heartwood decay and excavating high in the tree. Although larch heartwood is moderately resistant to decay (Manion 1981), it is susceptible to quinine fungus (*Fomitopsis officinalis*) and red ring rot (*Phellinus pini*; Fiedler and Lloyd 1995). Decay of this type develops slowly, over tens or hundreds of years at a rate usually not exceeding 100 cm^3 per year (A. D. Partridge, pers. comm.). Consequently, heartwood decay in larch is significant mainly in old, mature trees (Carlson et al. 1995) with young trees having a low incidence of decay (Boyce 1948, Schmidt et al. 1976, Manion 1981). Although sapsuckers usually nest in relatively small aspen and birch (Table 1), sapsucker selection of large larch was a result of decay related to size and age, not to size itself.

Sapsucker nest cavities in larch were high, usually near a broken top, which is a common point of entry for heartwood decay organisms (Manion 1981). Bark on the lower bole of large larch may be 15 cm thick, but it is much thinner on the upper bole (Schmidt et al. 1976). Sapsuckers excavated progressively lower on the upper bole in succeeding years. The first site selected for excavation may have had most heartwood decay (assuming decay entry through the broken top) combined with thin bark. This contrasts with aspen in which initial sapsucker nest-hole excavations are close to the ground and are progressively higher in ensuing years (Daily 1993). Heartwood decay reportedly invades aspen mostly at the base of the tree (Basham 1958, Shigo 1965).

Because sapsuckers usually make a fresh excavation each year (our data and Lawrence 1967), many nest holes from previous years are available for secondary cavity nesters. Kilham (1971:170) characterized such trees as "tenements." Although Mountain Chickadees and Red-breasted Nuthatches often excavate nest cavities in soft wood (Johnsgard 1986), undecayed larch wood apparently is too hard to penetrate. Their nests in old-growth larch depended on the presence of sapsuckers that in turn depended on the presence of heartwood decay.

Previously, old-growth larch forests have not been considered important habitat for Red-naped Sapsuckers. Our data make evident that in the northern Rocky Mountains, sapsuckers commonly nest in large larch with heartwood decay. Because heartwood decay incidence increases with age, habitat value to Red-naped Sapsuckers and other species is amplified in old growth forests. Consequently, the perpetuation of old-growth western larch forests should be an important component in the conservation of avian diversity.

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